DEVELOPMENT OF DIGITAL WIND SPEED METER WITH WIND DIRECTION

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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Control and Instrumentation)"

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Signature : ______________________________

Author : MOHD MOKHTAR BIN ISMAIL

Date : ______________________________

Dedicated to my dearest friend, whom without her,
I am nowhere near who I am now.

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May Allah reward His peace and blessings to all of you, and may this work brings benefit to the mankind.

ABSTRACT

An aerovane is one of the devices that is used to measure wind speed and direction. The wind speed measured using aerovane is much more acurate as it measures the speed of the wind which parallel to the wind direction. This project mainly focuses on using microcontroller PIC 16F877A to control the circuit and building the aerovane type wind vane model. Hall Effect sensor is used for speed measurement and 10kΩ potentiometer for direction detection. The sensor resolution for speed measurement is one pulse per rotation. For direction, the specific direction is determined at every 45° rotation of potentiometer. The microcontroller is used as a central contoller to measure the speed and direction of the wind and displays it on a 16 x 2 characters LCD. From the measured pulse per minute, the speed is calibrated for displaying the value in km/h. While the direction will be display in specific direction which is North, NorthEast, East, SouthEast, South, SouthWest, West, and NorthWest. Based on the output, the PIC 16F877A can be an ideal microcontroller for developing this project. However, the aerovane modelling should be done in more accurate manner to get more accurate wind measurement.

ABSTRAK

Kincir angin adalah merupakan salah satu alat yang digunakan untuk mengukur kelajuan dan arah angin. Kelajuan angin yang diukur oleh kincir angin adalah lebih tepat kerana ia mengukur angin yang selari dengan arahnya. Projek ini menumpu kepada menggunakan mikropengawal PIC 16F877A untuk mengawal litar dan membina model pengukur angin jenis kincir angin. Pengesan kesan Hall digunakan untuk mengukur kelajuan angin dan perintang boleh laras 10kΩ digunakan untuk mengukur arah. Resolusi pengesan kelajuan adalah satu denyut per pusingan. Untuk pengukur arah, arah tententu ditentukan setiap 45° pusingan oleh perintang boleh laras. Mikropengawal digunakan sebagai pengawal pusat untuk mengukur kelajuan dan arah angin dan memaparkannya pada 16 x 2 abjad LCD. Melalui denyut per minit yang telah diukur, nilai yang diperolehi akan disesuaikan untuk memaparkan nilai kelajuan angin dalam unit km/j. Arah angin pula akan dipaparkan dalam arah khusus iaitu Utara, Timur Laut, Timur, Tenggara, Selatan, Barat Daya, Barat, dan Barat Laut. Berdasarkan keluaran yang diperoleh, mikropengawal PIC 16F877A boleh menjadi mikropengawal yang ideal untuk membangunkan projek ini. Namun, pemodelan kincir angin perlu dilakukan dengan lebih terperinci untuk mendapatkan pengukuran angin yang lebih tepat.

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LIST OF SYMBOLS

°	-	Degree
s	-	Second
V	-	Voltage
GND	-	Ground
B_{OP}	-	Magnetic flux density operating point threshold
B_{RP}	-	Magnetic flux density release point threshold
B_{hys}	-	Magnetic flux density hysteresis
Ω	-	Ohm
F	-	Farad
km/h	-	Kilometer per hour
rpm	-	Rotation per minute
rps	-	Rotation per second
Hz	-	Hertz
m	-	Meter
A	-	Ampere

LIST OF ABBREVIATIONS

LCD	-	Liquid Crystal Display
N	-	North
S	-	South
E	-	East
W	-	West
NE	-	North East
SE	-	South East
SW	-	South West
NW	-	North West
I/O	-	Input or Output
ADC	-	Analog-to-digital converter
OSC	-	Oscillator

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CHAPTER 1

INTRODUCTION

1.1 Background

Weather measurement tools are important for human beings, used to determine the actual weather and forecasting, and wind is one of the weather elements that can be measured. It is a known fact that wind really influences our daily life. Good and even bad situations can be caused by wind. Wind brings rain from one place to another; cools down hot areas, and at some windy areas, wind can be used to generate electrical power. However, it can also bring disasters, such heavy rain which is very dangerous for people driving vehicles on the road, and not to mention, storm and hurricane which are capable of producing mass catastrophe. With the advancements in technology nowadays, measuring weather - especially wind, is made easily done and accurate since it can improve our quality of life.

Wind measurement tools are termed “Anemometer”. An anemometer is a device for measuring the velocity or the pressure of the wind, and is one of the instruments used in weather stations. The term is derived from the Greek word "anemos" meaning wind. There are six types of velocity anemometer [1];

1. Cup anemometers
2. Hot-wire anemometers
3. Laser Doppler anemometers
4. Sonic anemometers
5. Windmill anemometers

6. MEMS anemometers

In some instruments, wind speed measurement is not practiced. For example, in a wind direction tool called windsock. A windsock is a large, conical tube designed to indicate wind direction and relative wind speed. Windsocks typically are used in airports and in chemical plants in which there are risks of gaseous leakage. They are sometimes located alongside highways at windy locations. However, it does not show the magnitude of the wind speed. For better weather forecast, analysis and respond, a combination of wind speed and wind direction measurement is needed.

1.2 Objective of Project

The main core of this project is to design a wind measurement instrument for measuring wind speed and direction using a microcontroller. This system will display the current speed and direction of the wind on LCD.

1.3 Scope of Project

In order to achieve the objective of the project, several scopes have been outlined. The scope of this project are; using microcontroller PIC 16F877A for controlling the circuit, using hall effect sensor for speed measurement in RPM, using potentiometer for wind direction measurement (output is given in analog signal) and using LCD 16 characters, 2 lines for displaying the value of measured wind speed and direction. Besides that, the scope also includes building a working Aerovane model to be applied together with the wind speed and direction sensor.

1.4 Summary of Project

Implementation and works of the project are summarized into Figure 1.0 and Figure 1.1. Gantt charts as shown in Figure 1.2 and Figure 1.3 show the detail of the works of the project that has been implemented in the first and second semester.

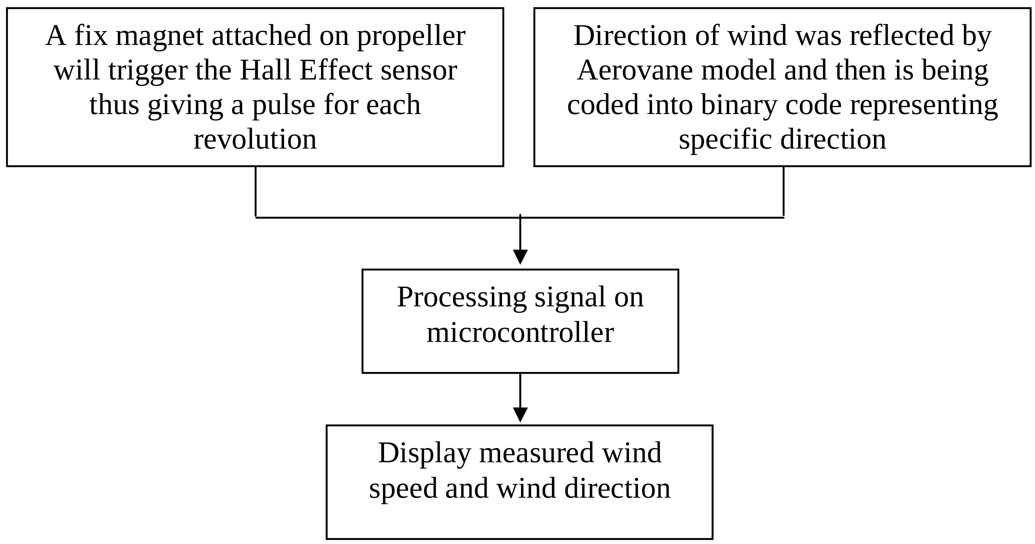

Figure 1.1 Block Diagram

Description:

A fix magnet is attached onto the Aerovane propeller. When the wind blows, the propeller will spin relative with the wind speed, thus the magnet will trigger the Hall Effect sensor. A pulse will be generated as an output for each revolution. The time difference from each pulse is used to calculate the speed of the wind.

At the same time, the tail of the Aerovane will direct according to wind direction. The Aerovane is attached with potentiometer which will give analog signal output with respect to the direction of the wind. The analog signal is being converted into 8-bit binary by the analog to digital converter module in microcontroller.

The output from Hall Effect sensor and potentiometer will be transmitted to microcontroller to be processed and calculated.

The calculated measurement will be displayed on the LCD. The LCD used is the 16 characters and 2 lines type. It will be displaying the speed of the wind in km/h unit with the direction of the wind in a specific direction.

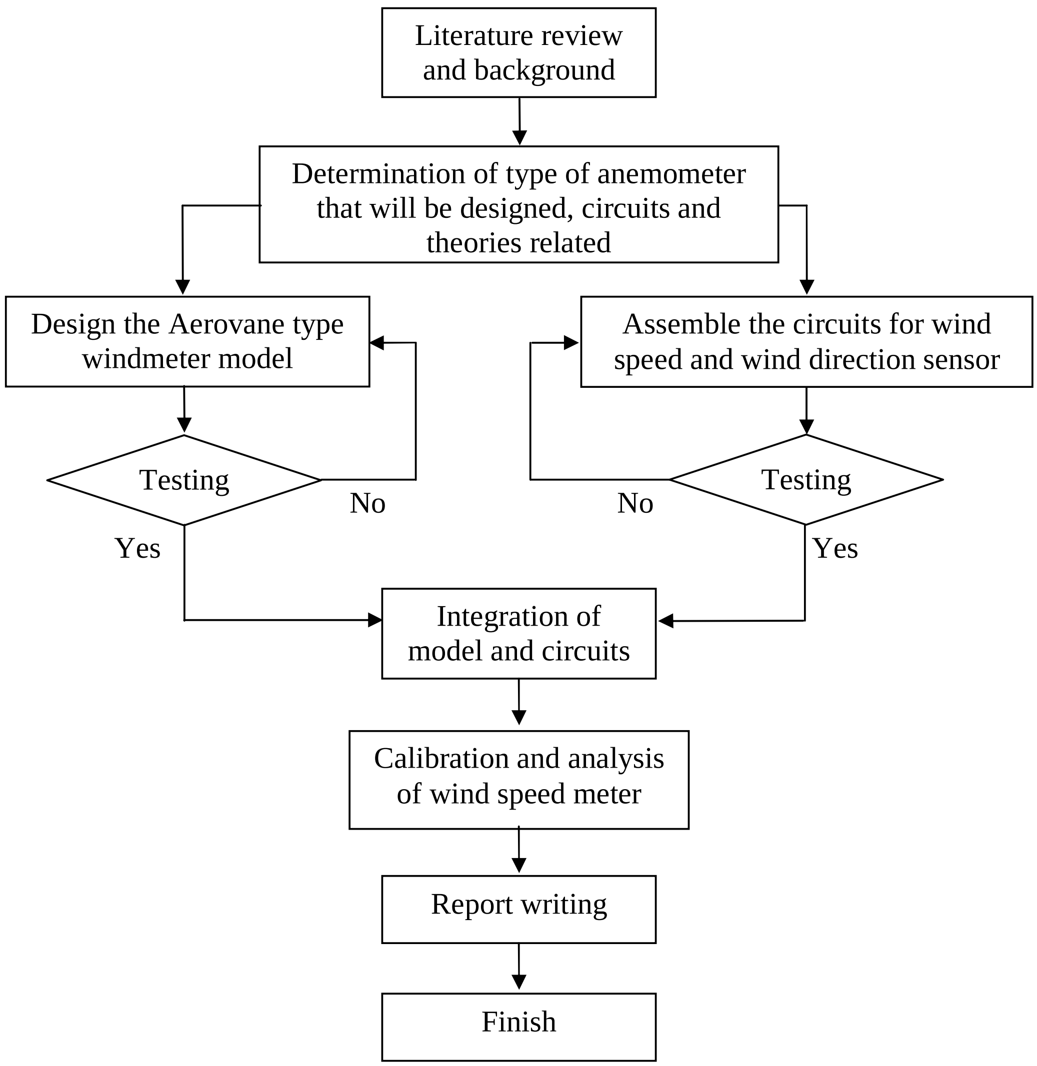

Figure 1.2 Flow of development

Description:

Literature review and research on theories related to the project begins after the title of the project was decided. These involve theories such as Hall Effect sensor, rotary encoder, potentiometer, anemometer, microcontroller and a few others. By obtaining most of the information from the internet and a few reference book, the Aerovane type was chosen to be developed in this project because it has both speed and direction measurement.

The project is divided into two parts; the modeling and the circuit. The modeling part involves developing a model of the Aerovane which has three main components; body, tail, and propeller. The body can move from right to left and back, and spin around according to the direction of the wind. It is supported by the tail. The propeller is the part where the Hall Effect sensor is attached. It will spin relative with wind speed.

The design (i.e. size, shape and weight) of the propeller is important to ensure a maximum read of wind speed. The main issue here is friction. The model must have as little friction as possible to ensure that the sensor is sensitive and that a more accurate reading is obtained. Using the contact less Hall Effect sensor on propeller and ball bearing on the body is essential.

For the circuit part, a microcontroller is used as the main element because one microcontroller can be programmed to have all the processes required in it. Calculation and providing output on digital display is done by microprocessor. It is cost efficient and flexible in usage. The Hall Effect sensor output can be connected directly to the microcontroller. LCD is used to display the output (speed and direction of wind) after the measurement process.

Integration of both the model and circuit will be done when both parts are ready.

Calibration process is the process of tuning the programming until the accepted speed value in metric unit is obtained. Calibration is needed for displaying the accepted value on the LCD as well as to reduce error.

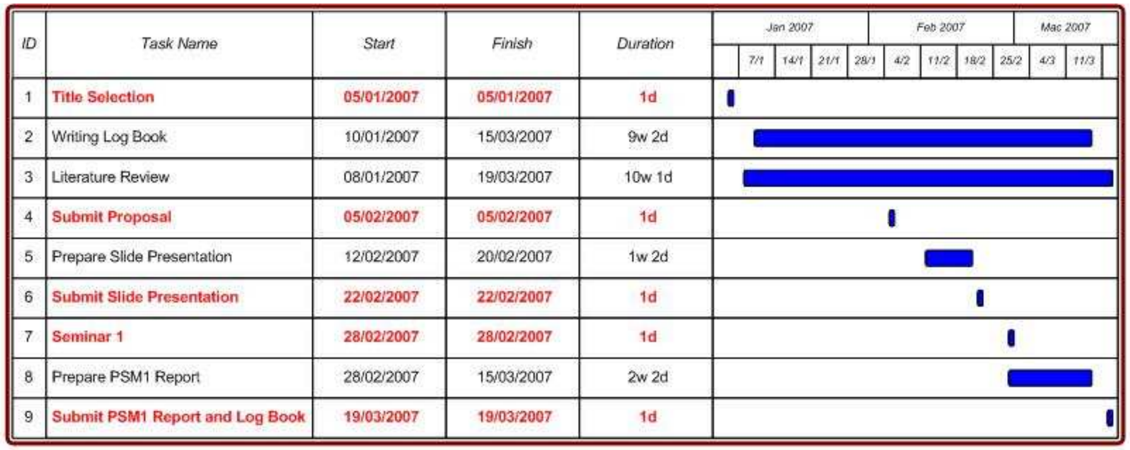

Figure 1.3 Gantt chart of the project schedule for semester 1

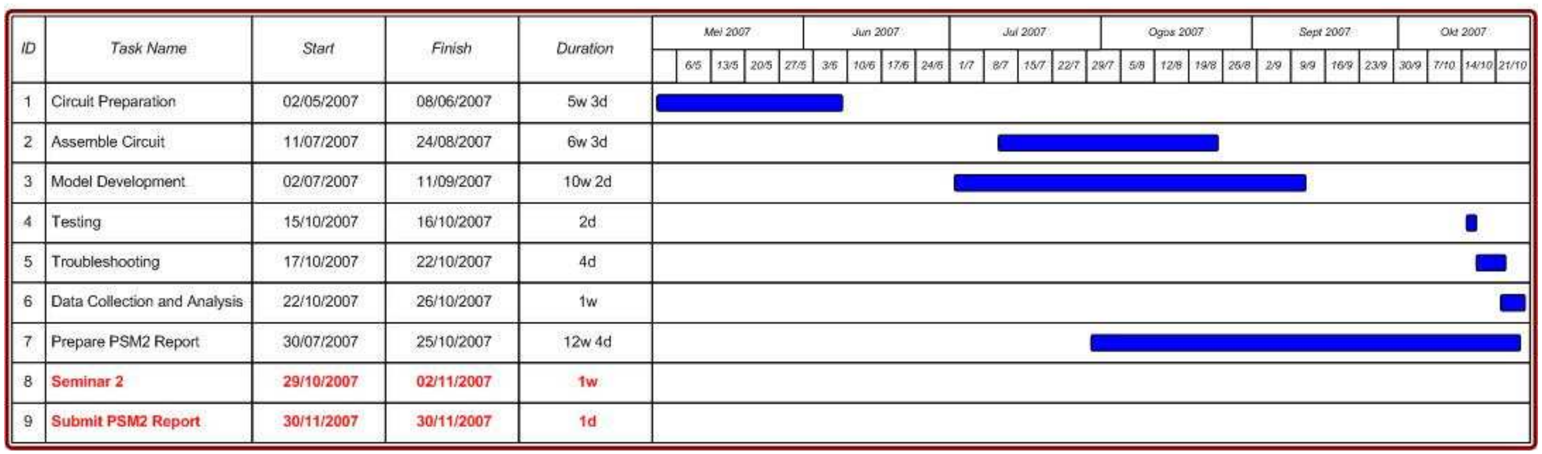

Figure 1.4 Gantt chart of the project schedule for semester 2